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Description

VARIABLE-GEOMETRY TURBINE STATOR BLADE, PARTICULARLY FOR AIRCRAFT ENGINES

BACKGROUND OF INVENTION

[0001] As is known, in variable-geometry turbines, the stator blades can be rotated about respective axes to adjust the gas flow section in the nozzles defined by the blades, and so improve turbine efficiency over a relatively wide range of operating conditions.

[0002] More specifically, the stator comprises two annular platforms defining a conduit, along which the gas flows, and which houses the airfoil profiles of the blades. Each airfoil profile is hinged to the two stator platforms, and comprises a tail portion defined radially, with respect to the turbine axis, by two end walls fitted in sliding manner to the platforms.

[0003] Given the high temperature of the gas conducted by the turbine, particularly in aircraft applications, the connect-

ing regions between the moving parts of the blades and the fixed parts of the stator must be cooled by streams of cooling air to prevent jamming of the blades and ensure accurate gas flow adjustment. More specifically, a need is felt to cool said end walls and improve heat exchange efficiency to minimize the amount of cooling air required.

SUMMARY OF INVENTION

[0004] The present invention relates to a variable-geometry turbine stator blade, particularly for aircraft engines.

[0005] It is an object of the present invention to meet the above requirement in a straightforward, low-cost manner.

[0006] According to the present invention, there is provided a blade for a stator of a variable-geometry turbine, particularly for aircraft engines; said stator comprising a supporting structure; said blade comprising an airfoil profile hinged to said supporting structure to rotate about an axis inside a conduit and comprising a high-pressure front wall and a low-pressure rear wall; two end walls located at opposite ends of said airfoil profile, with respect to a direction parallel to said axis, and cooperating in sliding manner with said supporting structure; and cooling means for cooling said end walls; said cooling means comprising a number of holes for the passage of a cooling

fluid from an inner cavity of said blade; characterized in that said holes have respective outlets close to an outer edge joining at least one of said end walls and said front wall.

Brief Description of Drawings

[0007] A non-limiting embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

[0008] Figure 1 shows a section, along the plane of the turbine axis (not shown), of a preferred embodiment of the variable-geometry turbine stator blade, particularly for aircraft engines, according to the present invention;

[0009] Figure 2 shows a larger-scale view in perspective, cut away in planes perpendicular to the Figure 1 plane, of a tail portion of the Figure 1 blade.

Detailed Description

[0010] Number 1 in Figure 1 indicates a variable-geometry axial turbine (shown partly) forming part of an aircraft engine (not shown) and axially symmetrical with respect to its axis (not shown).

[0011] Turbine 1 comprises a succession of coaxial stages, only one of which, indicated 10, is shown in Figure 1 and com-

prises a stator 11, and a rotor 12 downstream from stator 11.

[0012] Stator 11 comprises an outer annular platform 14 and an inner annular platform 15, which are positioned facing and define radially in-between an annular conduit 18 for conducting a stream of gas in expansion and increasing in mean diameter in the gas flow direction.

[0013] Platforms 14, 15 support a number of blades 19 (only one shown) equally spaced angularly about the turbine axis, and comprising respective airfoil profiles 20, which are housed inside conduit 18 and define between them, i.e. circumferentially with respect to the turbine axis, a number of nozzles.

[0014] As shown in Figure 1, each blade 19 also comprises two pins 21, 22, which are located at opposite ends of profile 20, are coaxial along an axis 24 incident with the turbine axis, are integral with a front portion 23 of profile 20, and are hinged to respective platforms 14, 15 to permit rotation of profile 20 about axis 24.

[0015] More specifically, blades 19 are rotated synchronously about respective axes 24 by an angular positioning assembly 25 shown partly and not described in detail.

[0016] Profile 20 of each blade 19 comprises an outwardly con-

vex rear wall 29 (Figure 2) defining a suction side for the relative nozzle, and an outwardly concave front wall 30 (Figure 2) defining a pressure side for the relative nozzle; and walls 29 and 30 are connected to each other along a leading edge 31 defining portion 23, and along a trailing edge 32 defining a tail portion 33 of profile 20.

[0017] At portion 33, walls 29, 30 are joined to each other by two end walls 34, 35, which are located at opposite ends of profile 20 in a direction parallel to axis 24 or radial with respective to the turbine axis, and cooperate in sliding manner with respective platforms 14, 15 as blades 19 rotate.

[0018] As shown in Figures 1 and 2, walls 29, 30, 34, 35 define an inner cavity 39 housing a box- or shell-like insert 41 made of sheet metal and in turn defining an inner cavity 42 for receiving, in known manner not described in detail, a stream of cooling air from outside blade 19 and along an axial passage 43 formed through pins 21, 22.

[0019] Insert 41 comprises two flat end walls 44, 45 facing respective walls 34, 35 and forced against certain areas (not shown) of walls 34, 35.

[0020] With reference to Figure 2, each wall 44, 45 comprises an intermediate portion 47 having through holes 48 formed

in a row substantially parallel to the curved mean "chord" of profile 20; and two end portions 49, 50 located on opposite sides of portion 47 and adjacent to respective walls 29, 30. Portion 50 has no holes, and portion 49 has through holes 51 formed in a row substantially parallel to wall 29 and converging with the row of holes 48 towards edge 32.

[0021] Insert 41 also comprises two lateral walls 54, 55 facing respective walls 29, 30 and each forced against two ribs 56 projecting inside cavity 39 and integrally from relative wall 29, 30. Walls 54, 55 have respective holes 57 (Figure 2), through which respective jets of cooling air flow from cavity 42 and "strike"profile 20 to cool profile 20 in a manner commonly referred to as "impingement".

[0022] Walls 54, 29, and likewise walls 55, 30, define an intermediate chamber 59; and two lateral chambers 60, 61, which are separated from chamber 59 by said two ribs 56, and communicate directly with respective passages 62 defined by walls 34, 44 and walls 35, 45.

[0023] Each passage 62 communicates with cavity 42 through holes 48, 51, and with conduit 18 through a relative number of holes 68, which are formed through wall 34, 35, as an extension of chamber 60, 61, along respective axes

substantially parallel to axis 24, and have respective outlets 69 in a row parallel to the outer edge 70, 71 joining wall 30 to wall 34, 35.

[0024] In actual use, cooling air is directed from cavity 42, on the one hand, into chambers 59 and onto walls 29, 30 to cool profile 20, and, on the other, through holes 48, 51 into the two passages 62, where walls 34, 44 and walls 35, 45 guide respective tangential streams F1 of cooling air (Figure 2) to holes 68, i.e. from the low-pressure to the high-pressure side.

[0025] The air from outlets 69 is channelled into gaps 72 defined between platforms 14, 15 and walls 34, 35 (Figure 1) to form another two streams F2 of cooling air (Figure 2), which are tangential to walls 34, 35, are directed from the high-pressure to the low-pressure side by the pressure difference acting in the nozzles of conduit 18 on walls 29, 30, and therefore flow in the opposite direction to streams F1.

[0026] Passages 62, holes 68, and walls 44, 45 therefore form part of a device 74 for cooling walls 34, 35 by tangential streams F1, F2 of cooling air, and so achieving relatively high heat exchange efficiency enabling a reduction in the maximum amount of air required to cool walls 34, 35.

[0027] More specifically, a number of holes 68 terminating inside conduit 18, close to edges 70, 71, need simply be formed, leaving the rest of walls 34, 35 unchanged, to obtain streams F2, which are generated in gaps 72 by the pressure difference between the high-pressure and low-pressure sides of profile 20.

[0028] Moreover, walls 44, 45, and particularly portions 50 with no holes, guide the air in streams F1 towards holes 68 in the opposite direction to streams F2, thus improving the heat exchange efficiency of device 74.

[0029] Moreover, forming two rows of holes, as opposed to one, in walls 44, 45 and relatively far from edges 70, 71 provides for optimum, even cooling of the inside of walls 34, 35.

[0030] Finally, in addition to locating insert 41, ribs 56 also keep streams F1 separate from chambers 59, and therefore from most of the cooling system of walls 29, 30 defined by holes 57 in walls 54, 55 of insert 41.

[0031] Clearly, changes may be made to blade 19 as described herein with reference to the accompanying drawings, without, however, departing from the scope of the present invention.

[0032] In particular, holes 68 may be arranged along edges 70,

71 otherwise than as shown in Figure 2, and holes 48, 51 may be formed in other than the preferred positions illustrated.